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# Assessment of bio-degradability of bio-synthetic fabrics

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**Abstract**
Sustainability, industrial ecology, eco-efficiency, and green chemistry are guiding the development of the next generation of materials, products, and processes. With advancement of science & technology, products beyond our present perception can be produced. In the concerned paper innovations in fibers being called as bio-degradable has been discovered. Five different bio-synthetic fabrics were assessed for their bio-degradable properties. Soil burial test and anti-microbial colony reduction test were performed. All the fabrics showed the bio-degradable properties which supports that the bio- fibers are environmental friendly fibers so it has been more demand in future. The development of special fibers is the consequence of merging fundamentals scientific and technical knowledge, as there is a quest for high performance fibres.

**Keywords:** Bio-synthetic, sustainable, bio-degradation, soil burial, anti-microbial

## 1. Introduction
As a famous Scandinavian economist said, ―It is very dangerous to make predictions, particularly about the future! Whenever term futuristic disucssed, it deals with expressing the vision of future. Sustainability, industrial ecology, eco-efficiency, and green chemistry are guiding the development of the next generation of materials, products, and processes [Mohanty *et al*. 2002] [1]. For thousands of years, natural fibres have been at the core of the textile industry. From cloth, to paper and building materials, natural fibres were always the base material. According to the United Nations Food and Agriculture Organization, natural fibres are substances produced by plants and animals that can be spun into filaments or thread. Natural fibres originate from either plant fibres, such as coir, cotton and flax, or animal fibres such as camel hair, alpaca wool, and cashmere. As a completely renewable resource, natural fibres provide many benefits both to the environment and to those involved in the market that they create [Bains 2012] [2].
With increasing concerns regarding the effect the textile industry is having on the environment, more and more textile researchers, producers and manufacturers are looking to biodegradable and sustainable fibres as an effective way of reducing the impact textiles have on the environment. The emphasis in Biodegradable and sustainable fibres is on textiles that are beneficial by their biodegradation and come from sustainable sources.
Biodegradable and sustainable fibres open with a discussion of microbial processes in fibre degradation [Blackburn 2005] [3].

### 1.1 Bio-synthetic fibers
Biobased synthetic textiles like Modal, corn, banana, milk, and bamboo and soy fabrics have become a heavily invested area of research and development in modern textile experimentation in the more than $400 billion textile industry. Recent technologies have provided a platform for manipulation of natural plant matter, producing engineered textiles that are essentially considered “natural” as they are derived from plants and other natural sources.

- Bio-synthetic fibers include;
- Bamboo (from bamboo plants)
- Banana (from banana trees)
- Chitin (made from crab and shrimp shells)
- Corn (made from corn plant sugars)
- Cupro (made from cotton plant lintels)

- Milk (milk proteins)
- Rayon, tencel and viscose (derived from wood cellulose)
- SeaCell® (seaweed)
- Soy (made from soybeans, perhaps leftover from making Tofu) [Oijala 2013] [4]

Bio-synthetic yarns are created by cooking cellulose (or polymers) into a slurry and then pumping that slurry through the tiny holes of a spinnarette and voila, fiber filaments are produced that are then spun into yarn [Lkaline 2010] [5].

1.2 Importance of sustainable fibers

"Textile School, 2018" dicussed the importance of sustainable fibers in an article are as follows:

- **Social responsibility:** Chemicals and pesticides invade drinking water and groundwater, polluting its fish and even reaching human consumption. Organic and eco fibers grow without any pesticides or chemical fertilizers.
- **Biodegradable:** Eco and organic fabric biodegrade naturally over time. Synthetic fibers eventually become waste and let off harmful toxins when they degrade.
- **Health:** Many people are allergic or dislike wearing synthetic textiles. Eco fabrics have all the properties of the new synthetic breathable fibers with added softness and drape. They feel better against the skin.
- **Absorption:** Not only do its chemicals reach the groundwater, conventional clothing is worn next to the most porous organ-skin. Organic and eco-fibers are natural and do not contain irritating chemicals. Many of them are also considered hypoallergenic and naturally anti-bacterial.
- **Popularity:** Organic foods have been around for awhile and it is a natural evolution that organic and eco-friendly fabrics will also gain popularity. Eco and Organic fabrics once considered an alternative is now entering into the mainstream.

**1.3 Biodegradation**

The mechanisms by which polymers/fibres degrade vary depending on the material. These degradation mechanisms include biodegradation, hydrolysis and photo degradation. Some materials degrade solely by one mechanism alone, while others degrade by a combination of mechanisms. The environment where the polymer/fibre is disposed has a great effect in the types of degradation that can occur. A 'degradable' material disposed in an inappropriate environment may not degrade at all.

"Textile innovation knowledge platform" (n.d.) dicussed in the broadest sense, biodegradation is the biologically catalyzed reduction in the size and complexity of a molecule. This breakdown is carried out by Microorganisms which, because they are living entities, require suitable conditions such as optimum pH and temperature in the composting process. (Fig. 1). With reduction in landfill more and more food waste is being composted.

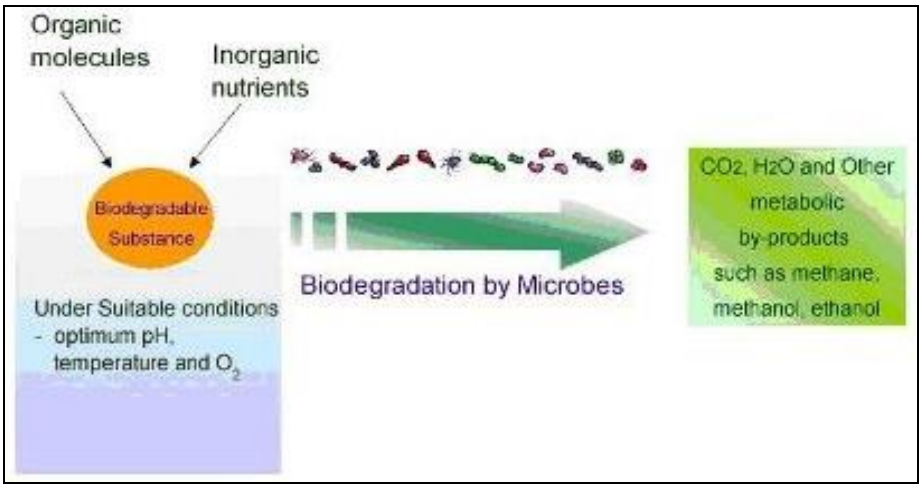


**Fig 1:** Biodegradability process

The present study was conducted to assess the level of bio-degradability of all the bio-synthetic fabrics to check their impact on environment.

**2. Material and Methods**

Fabrics selected for the study were corn, milk protein, bamboo, banana and soya protein.

**2.1 Soil burial test**

Biodegradability is very important as a parameter of the environmental behaviour of a substance. Among the methods used to determine the biodegradability of tissue papers, the Soil Burial Test (SBT) has been proposed using IS 1623 standard.

Compost is prepared by mixing fertile garden soil, cowdung manure and sand in the proportion of 2:1:1. Moisture content is controlled to 25 to 27 percent. Soil is taken in different beakers. A weighed amount of each samples i.e. banana, bamboo, corn, soya protein and milk protein fabrics were rolled in cylindrical form and put in the beakers such that soil covers the sample from all the sides. The beakers are covered with aluminum foil and keep it in room temperature for 21 days. The weight of all the samples will be checked after 21 days [Musmeci 1993] [8]

Total percent weight loss after 21 months was calculated as:

$$\% \text{ Wt.Loss} = \frac{\text{Initial wt. at the beginning -Final wt. after 21 days}}{\text{Initial wt. at the beginning}} \times 100$$

**2.2 Anti-bacterial assessment**

This test was performed to assess the anti-bacterial potential of the bio-synthetic fabrics using AATCC test method 100-2014 by calculating the bacterial colony reduction %.

This test method provides a quantitative procedure for the evaluation of the degree of antibacterial activity. Assessment

of antibacterial properties on textile materials is determined by the degree of antibacterial activity intended in the use of such materials. However, if bactericidal activity is intended or implied, quantitative evaluation is necessary. Quantitative evaluation also provides a clearer picture for possible uses of such textile materials.

The antibacterial properties were tested against Escherichia coli which is a Gram-negative bacterium.

## 3 Results and Discussion

### 3.1 Soil burial test

Bio-degradability of all the five bio-synthetic fabrics was assessed.

**Table 1:** Bio-degradability % of bio-synthetic fabrics

| Si. No | Fabric | Initial Wt | Final Wt | Degradation % |
|---|---|---|---|---|
| 1 | Banana | 0.70g | 0.55g | 21.42% |
| 2 | Bamboo | 0.80g | 0.55g | 31.25% |
| 3 | Milk | 0.85g | 0.40g | 53.00% |
| 4 | Soya | 0.75g | 0.45g | 40.00% |
| 5 | Corn | 0.75g | 0.40g | 46.66% |

Table 1 shows the degradation % on the basis of weight loss for each of the fabric. As per the table 1, Milk protein fabric with 53% achieved the maximum of degradation whereas banana fabric showed the minimum degradation with only 21.42% of fabric weight loss.

a b c d e

**Fig 2:** Bio-synthetic fabrics (a) Banana (b) Bamboo (c) Milk protien (d) Soya protien (e) Corn

### 3.2 Anti microbial test

**Table 2:** Anti microbial assessment by colony reduction method

| Si. No | Samples | No. of bacterial colonies | Colony Reduction % |
|---|---|---|---|
| 1 | Controlled slide | 1672 | - |
| | Bio-synthetic fabric | | |
| 2 | Banana | 230 | 86.2 |
| 3 | Bamboo | 117 | 89.4 |
| 4 | Milk protein | 80 | 95 |
| 5 | Soya protein | 294 | 82 |
| 6 | Corn | 179 | 89.2 |

Table 2 shows the anti-microbial assessment on all 5 fabrics by counting number of bacterial colonies and colony reduction %. From the above table, all the fabrics have shown a good amount of anti-bacterial activity. The maximum colony reduction was seen in milk protein fabric i.e. 95%, whereas bamboo and corn fabric shows the similar % of 89. The minimum colony reduction was found in soya protein fabric.

Today synthetic fibers are not a mere alternative to natural fibers but are new materials of high functionality and high performance, which play a key role in the field of high technology. These new materials can be designed and produced according to nature of their utilization [Ali *et al.* 2015] [10]

Casein, the milk protein, is based on 18 of the 22 known proteinogenic amino acids and it has an extremely high glutamine and calcium content. At about 20 percent, no other protein contains as much glutamine as casein with the pH of 6.8 (same as the human skin) (http://www.patrickyarns.com/green-recycled/milk-protein/). Additionally, its moisture management function prevents the growth of bacteria by 99 percent and promotes temperature regulation that can suppress allergens. It has natural antibacterial effects against E. coli and even Staphyllococcus aureus, and is resistant to fuels, making it suitable for a range of products in the clothing, home textiles and technical market. [Domask and Preus 2013] [11].

4. Conclusion

Sustainability has become an essential attribute of today's textile and clothing industry, the process of transforming textile industry into more sustainable one is very sensitive, needs a lot of knowledge, skills and commitment [Ali and Sarvar 2010] [12]

New high-tech textiles are the materials of the future and will need to comply with high sustainability standards. Most prevalent is the trend toward biodegradable fiber materials from biopolymers. The demand in eco-friendly products is rising and, due to the increasing scarcity of resources, many researchers are looking to novel fiber alternatives.

"Phys Org" (2017) [12] said, "New protein fibres are going to be a great addition to the world of sustainability," as they offer "the possibility of a renewable starting and a recyclable endpoint for materials that actually feel good and perform in the ways you need."

The bio- fibers are environmental friendly fibers so it has been more demand in future. The development of special fibers is the consequence of merging fundamentals scientific and technical knowledge, as there is a quest for high performance fibres.

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